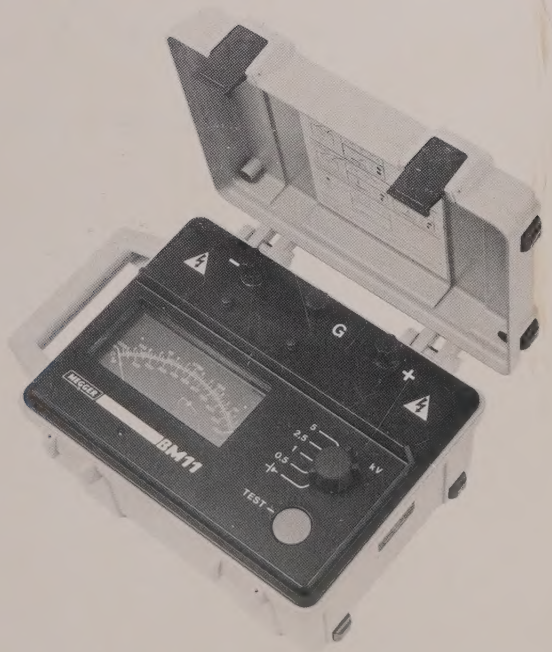
BM11

Battery MEGGER Tester

#218650



THORN EMI

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MEGGER®

Operating Instructions

Safety in the Use of Electrical Equipment

It should be understood that any use of electricity inherently involves some degree of safety hazard.

Various safety regulations and recommendations are in existence and new ones are being formulated in an attempt to reduce the extent of such hazard. This is achieved principally by defining, as far as possible, the levels of voltage and current above which there is significant hazard; by establishing certain principles in the design of equipment and by recommending specific visual warnings of any residual hazard, to be placed on the equipment.

We, in common with other responsible manufacturers, take all reasonable steps to ensure that our products comply with relevant approved safety standards. However, it must be emphasised that certain types of electrical testing essentially involve the use of voltages and currents above the limits defined as 'safe' values. For example, insulation testing and flash testing generally require the use of high voltages well above the safe limit and it may not always be possible to restrict the currents available from the test equipment to within the defined safe values.

It is recommended that the user of electrical equipment of any sort should always ensure that he understands, in detail, the equipment's characteristics so that he is aware of the degree of safety hazard which may be involved.

Whilst every effort is made by responsible manufacturers to reduce the hazards and to warn of any hazard remaining, it still rests with the user to play his part in ensuring his own safety.

The best way to achieve this is:–

- ★ **UNDERSTAND THE EQUIPMENT YOU ARE PROPOSING TO USE, AND ITS RATINGS.**
- ★ **UNDERSTAND THE APPLICATION TO WHICH THE EQUIPMENT IS TO BE PUT.**
- ★ **ENSURE THAT ALL REASONABLE SAFETY PROCEDURES ARE FOLLOWED.**
- ★ **TAKE NO CHANCES, NOR SHORT-CUTS IN SAFETY PROCEDURES.**

The equipment described in this book has been examined, both in design and manufacture, to ensure that safety hazards are minimised.

Any known remaining hazards are explained in the paragraph headed "WARNING" on page 10.

If, for some specific application, it is found that the information provided is not adequate, then please contact the manufacturer for further details and assistance.

WARNING

Before making any insulation measurements the battery charger power supply lead MUST be removed from the instrument and the battery charger socket cover replaced.

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General Description

The BM11 is a battery operated, portable, high voltage insulation tester measuring up to 100 GΩ resistance. Four test voltages are available 0,5 kV, 1 kV, 2,5 kV and 5 kV each with the same analogue resistance measuring range. The tester will also act as a voltmeter reading up to 1000 V a.c. or d.c. and thus providing two important features. Firstly, giving an automatic indication that the equipment on test is de-energised before testing commences, and secondly acting as a capacitive circuit discharge monitor. The tester automatically becomes a voltmeter when the 'TEST' push-button is not pressed.

The power is obtained from rechargeable batteries and the tester has an integral battery charger unit operating from a 100 V — 250 V, 50 Hz — 60 Hz mains power supply. Indication is given by the pointer, when the battery is approaching its fully exhausted state, but also a separate battery check is provided.

The instrument circuitry is divided into two parts, a high voltage generator and a measurement circuit. The high voltage is obtained from a stored energy inverter while an 'electronic cross-coils' circuit, (an electronic version of the well proven Evershed Cross-coils ohmmeter), is used for the measurement and yields the readings directly in ohms. The inverter circuit makes efficient use of the available battery power while giving rapid charging of capacitive circuits under test. These circuits are automatically discharged after testing when the 'TEST' push-button is released.

The tester is contained in a robust, moulded plastic case with a carrying handle and has a hinged, detachable lid for protecting the front panel.

The controls, meter and terminals are mounted on the front panel. A five position rotary switch is provided for selecting the test voltage required or the battery check facility. The 'TEST' push-button must be pressed to energise the circuit and perform an insulation test. It is recessed into the panel to reduce the risk of accidental operation and can be locked in the pressed ('on') position by a clockwise rotation. Three screw-down type terminals are provided marked '+' '−' and 'G'. The equipment to be tested is connected to the '+' and '−' terminals. 'G' is a guard terminal, to enable errors caused by surface leakage to be eliminated (see page 12 for details on the use of the guard terminal). The meter, a moving coil type, has a black scale plate, white markings and an orange knife edge pointer. The upper scale is for insulation resistance measurements and is calibrated from 100 kΩ to 100 GΩ with 0 and ∞ also marked, the lower scale marked 0 to 1000 is for voltage measurements. (If the selector switch is set to 'battery check', instead of one of the test voltage positions, this will have an effect on the voltage reading. However, a voltage indication will still be given). The mains input socket for battery charging is mounted below a removable sealed cover, where a red mains indicating lamp is also to be found.

The tester is supplied with three test leads terminated with clips and a mains supply lead for battery charging.

Applications

The BM11 battery MEGGER tester may be used for routine insulation resistance measurements on many components such as motors, generators, transformers, high voltage insulators, power cables and wiring installations. Because it is battery operated it is particularly suitable for service and field applications.

The tester can be employed in the routine maintenance of plant and installations, to make measurments showing the state of the insulation when in service and the amount of degradation that takes place due to the effects of corrosion, dirt, grease, moisture etc. From such results the future performance of these items can be estimated and interruptions or breakdowns avoided.

Step-voltage tests, whether these are at the full rating or below, can be used to indicate the condition of insulation subjected to moisture and dirt, or point to a weakness. A ratio of 1:5 in the test voltage is suitable and if the tests are carried out for a similar period of time, a difference between the resistance readings of the lower voltage test and higher voltage test, points to a weakness in the insulation. Absolute values of insulation resistance are not of great importance but the change in resistance is indicative of the trend in the insulation condition. Such tests are valuable when performed regularly on a scheduled basis and a record of results kept.

Dielectric Absorption testing, which involves insulation tests on capacitive circuits for several minutes, is also possible.

The safety of electrical installations and apparatus depends upon the condition of the insulation and it is essential that this is thoroughly checked when new equipment is installed. The test voltage applied should be high enough to break through any mechanical flaws arising from manufacture or installation.

The tester can also be used to monitor the improvement in insulation within motor, generator and transformer windings etc. that result from drying out procedures following their service in excessively humid atmospheres.

Specification

Ranges	
Insulation resistance range	100 kΩ to 100 GΩ at all test voltages.
Test voltage d.c.	500 V 1 kV 2,5 kV 5 kV.
Voltage range a.c. or d.c.	50 V to 1000 V.
Accuracy (at 20°C)	
Insulation resistance range	± 1,5% of arc length. (± 20% of reading from 1 MΩ to 10 GΩ).
Test voltage	± 5% on open circuit.
Short Circuit Current	1 mA nominal, 2 mA maximum.
Ripple Content	< 10 V pk-pk worst case (R < 10 MΩ).
Capacitor Charging Time	< 18s to charge a 2 μF capacitor to the 1 GΩ mark at 5 kV.
Capacitor Discharging Time	< 2s to discharge a 2 μF capacitor from 5 kV to 50 V. Automatic when test button is released. Discharge voltage monitored on the meter.
Hum Rejection (50 Hz–60 Hz)	Will measure with up to 2 mA r.m.s. hum current (a.c. interference) on 5 kV range.
Maximum Continuous Overload (externally applied voltage)	1 kV for test terminals 250 V for guard terminal
Temperature Coefficient	< 0,04% of arc length/°C (< 0,5% of reading /°C from 1 MΩ to 10 GΩ)
Temperature Range	operating − 15 °C to + 55 °C storage − 40 °C to + 65 °C
Scale Length	123 mm

Specification

Power Supply	NiCd battery pack of 2 Ah capacity Battery life:– typically 8 h continuous (varying between 2 h and 20 h depending upon load conditions) Battery charging:– built-in charging unit, operating from 100 V — 250 V a.c. supply, 50 Hz or 60 Hz Charging time:– 16 h Low battery voltage indication:– small oscillations of the pointer occur with an approx. 80% exhausted battery. Large pointer oscillations occur when the battery must be recharged.
Dimensions	344 x 245 x 158 mm (13½ x 9⅝ x 6¼ in)
Weight	4,8 kg (10½ lb) excluding leads

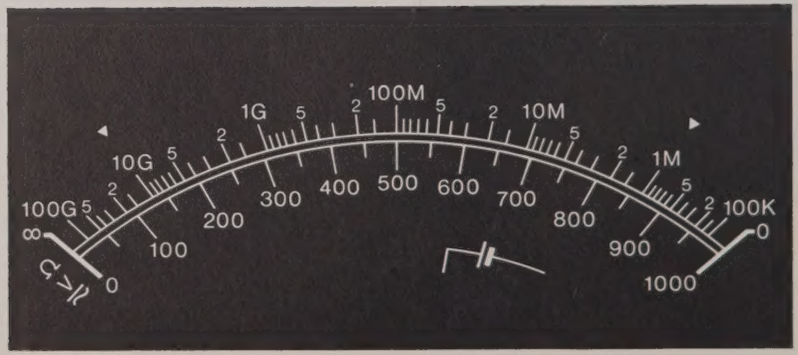
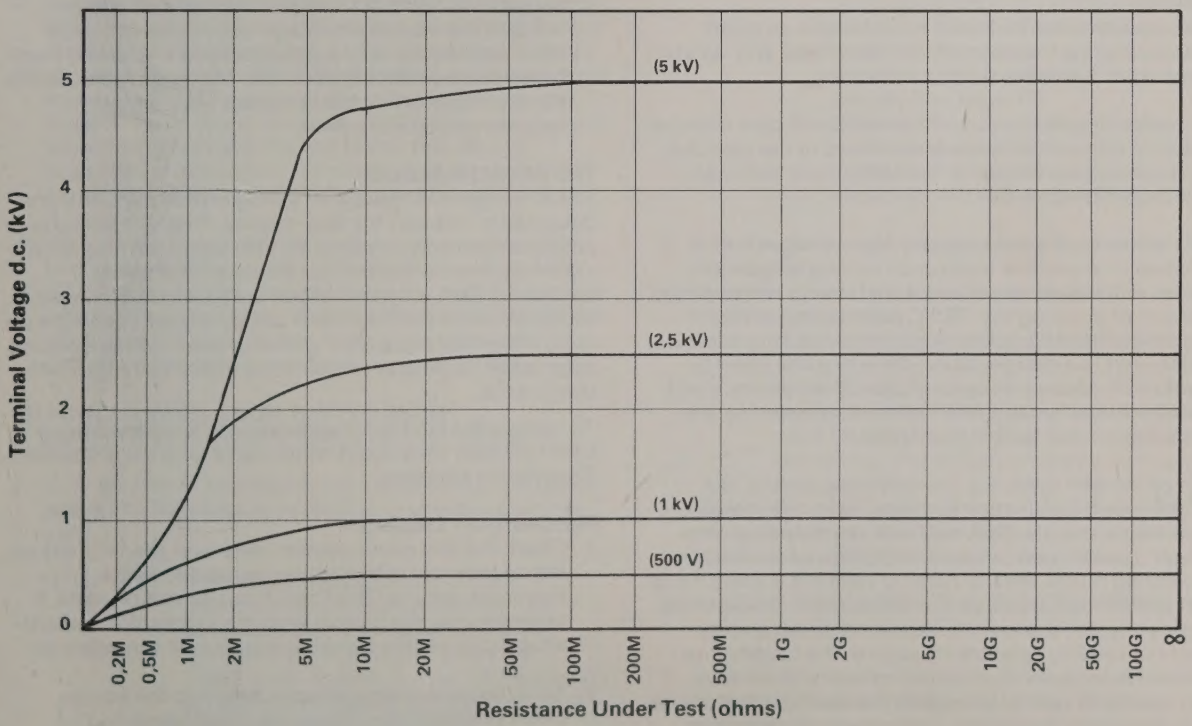


Illustration of BM11 scale (not full size)



Typical terminal voltage characteristics

Operation

WARNING

1. The equipment to be tested must be de-energised. Before making insulation tests, disconnect and isolate apparatus that is the subject of the test.

2. In connecting the instrument to the circuit care must be taken to ensure that there is no hazard to the user due to the voltage produced at the instrument terminals, which can be up to 5kV.

3. The instrument generates very high voltages which, applied to capacitive loads such as long lengths of cable, will usually produce a lethal charge within half a second of pressing the 'TEST' push-button. If the capacitive load becomes disconnected during a test it will be left in a charged state. Care must be taken to avoid this. Also when testing capacitive circuits, check that the meter reads <50V before disconnecting the instrument after carrying out a test.

4. For prolonged tests, e.g. on capacitive circuits, the 'TEST' push-button may be locked down by pressing and then turning it clockwise with the thumb or fore-finger. Care should be taken, with the instrument in this operating mode, that no harm or damage is done if it is left unattended, because it is producing a dangerously high voltage. To prevent excessive discharge to the point of causing possible damage to the battery, it is advisable to check the instrument every 15 minutes. **For optimum safety, never lock the push-button unless it is absolutely necessary.** Care should be taken that excessive voltages are not applied to the terminals. Maximum continuous voltage that may be applied, (from an external source), between the '+' and '−' terminals is 1000V and between the guard 'G' and '−' terminals is 250V. If the meter indicates a voltage >1000V the source of voltage must be removed as soon as possible (5kV applied between '+' and '−' will cause damage after approx. 5s). Maximum permissible current injected into the terminals from a high impedance source is 2mA.

THE DETACHABLE LID

The lid hinges are fitted with spring loaded clips and are designed in this way for two reasons. Firstly, if the lid is accidentally thrown open to its full extent, the hinges will not be strained or broken but the lid will be safely unclipped. Secondly, the lid can purposely be removed, if required, when the tester is in use by simply opening it up to its full extent and gently pressing down on the opening edge while holding the tester body firm. The hinges will then unclip.

To replace the lid, hold it vertically and push the hinges back into their clips again while restraining the instrument. Then fold the lid shut.

PRELIMINARY CHECKS

1. Check that the meter pointer rests over the '∞' mark on the upper scale with nothing connected to the terminals and the 'TEST' push-button **not** pressed. If necessary set the pointer with the mechanical adjuster situated below the meter, using a small screwdriver.

2. Turn the test voltage selector switch to the battery check position '⊣⊢'. Press the 'TEST' push-button and check that the meter reads to the right of the battery check mark on the scale shown thus . Release the push-button.

3. Connect the test leads to the '+' and '−' terminals and ensure that the clips are not touching anything. Set the test voltage selector switch to the appropriate voltage required. Press the 'TEST' push-button and observe the meter reading. The pointer should come to rest very close to the '∞' mark on the scale. If it does not, leakage is occurring between the test leads, test clips or possibly the instrument terminals. Release the push-button and check to find the leakage source.

4. With the test leads still connected to the instrument, join together the '+' and '−' test lead clips. Press the 'TEST' push-button and check that the meter reading is zero on the upper scale. Release the push-button. If the reading is not zero the test leads are suspect and should be inspected for a fault, i.e. open circuit.

MAKING AN INSULATION TEST TO EARTH

1. Perform the Preliminary Checks as given above

2. Connect the '+' test lead to the equipment to be tested, and the '−' test lead to earth (frame of the equipment etc).

   Note:— (i) if the equipment on test is not de-energised the voltage present will be automatically indicated on the lower scale of the meter. Do not press the 'TEST' push-button, but switch the circuit off and ensure that no voltage is present before proceeding with a test.

   (ii) If the equipment to be tested is known to be de-energised yet a voltage reading is obtained, this is indicative of the presence of a.c. interference currents caused by capacitive or inductive coupling to live circuits (see page 13).

   (iii) Although it is normal to connect the '−' terminal to earth, the '+' terminal might equally well be used. Accuracy of measurement will not be affected.

3. With the correct test voltage selected, press the 'TEST' push-button.
4. Read the value of the insulation resistance directly from the upper scale.

   Note:— If, when taking a reading, the pointer displays small oscillations, this is an indication that the battery is becoming exhausted. When the pointer oscillations become large the battery must be recharged before any more tests are carried out. For battery charging instructions see page 13.

5. Release the push-button and wait until the meter voltage reading is less than 50 V (shown on the lower scale) before disconnecting the test leads.

MAKING AN INSULATION TEST BETWEEN WIRES

1. Perform the Preliminary Checks as given above.

2. Connect one test lead to each conductor and then proceed as before in steps (3), (4) and (5) for an Insulation Test to Earth.

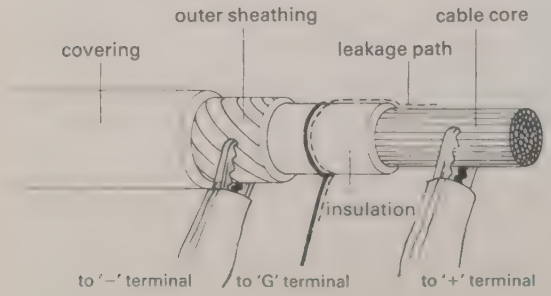
USING THE GUARD TERMINAL

For basic insulation tests the guard terminal will not be used.

Most insulation tests can be performed by connecting the specimen between the '+' and '−' terminals. These tests will show up any deficiencies in the insulation, whether they are caused by leakage through the insulator body or across its surface.

To distinguish between body leakage and surface leakage the guard terminal 'G' may be used. In this way surface leakage current is removed before it enters the measurement circuit via the '−' terminal.

In cable testing, there may be a path of leakage across the insulation between the bared cable and the external sheathing, perhaps due to the presence of moisture or dirt. Where it is required to remove the effect of this leakage, particularly at high testing voltages, a bare wire may be bound tightly around the insulation and connected via the third test lead to the guard terminal 'G'.



Since the leakage resistance is effectively in parallel with the resistance to be measured, the use of the guard causes the current flowing through the surface leakage to be diverted from the measuring circuit. The tester therefore, gives more nearly the true insulation resistance.

When the guard terminal is connected it will cause two other errors, which, although usually negligible, can affect the measurement if the surface leakage resistance is <20 MΩ approx. These are:

(i) The leakage resistance has a loading effect on the voltage at the '+' terminal which causes the actual voltage at the terminal to be slightly less than the voltage sensed by the reference circuit and results in a measurement error.

(ii) The leakage current shunts a small proportion of current away from the measuring circuit and results in a measuring error.

A 20 MΩ surface leakage resistance will produce a typical error of 0,5% of scale length. Serious errors will only occur if the surface leakage resistance is so low that the power available is insufficient to generate the required voltage across the surface leakage resistance. Refer to the graph of voltage characteristics on page 9.

LOW BATTERY INDICATION

If the pointer displays small oscillations (approx. 2 mm amplitude at 1 Hz) during an insulation test, this indicates that the battery is more than 80% exhausted. The instrument can still be used in this condition but the battery should be re-charged at the earliest opportunity.

If the pointer displays large oscillations (approx. 50 mm amplitude, thus making it impossible to take a reading) the instrument must not be used until the battery has

been re-charged. It is preferable never to allow this condition to be reached as excessive discharge can cause permanent damage to the battery. If the instrument is stored the battery will lose its charge over a period of several months. This will not cause any damage to the battery but charging will be necessary before the instrument is used. Moderate over-charging will do no harm and the battery can be charged on a regular basis (e.g. monthly) to keep the instrument serviceable.

CHARGING THE BATTERY

Note:— The instrument should not be used for insulation testing whilst the battery is being charged.

1. Disconnect the tester from any external circuit and remove the test leads.
2. Remove the battery charger socket cover, situated adjacent to the terminals by pulling up on the two cover clips.
3. With a suitable mains supply plug connected to the battery lead, plug the lead into the instrument and then into a 100 V – 250 V, 50 Hz – 60 Hz mains power supply.
4. Switch the supply on and leave the battery to charge for 16 hours (power consumption is about 12 W). A red indicating light next to the charging socket will be illuminated while the battery is being charged.
5. After charging, switch off the mains supply, and remove the battery charging lead.
6. Before commencing insulation tests, replace the battery charger socket cover and secure it by pressing down on the two cover clips.
   Note:— When the charger socket cover is removed this opens a vent in the instrument and allows any moisture which may have accumulated to escape. It is therefore necessary to charge the battery in dry conditions and most important to replace the charger socket cover before the instrument is taken out for field use.

The battery should remain serviceable for at least five years if:

(a) it is never allowed to discharge completely.
(b) it is not subjected to high temperature for long periods of time. (Temperatures greater than 50 °C for more than 8 hours per day, will considerably reduce the battery life).

A.C. INTERFERENCE

The amount of a.c. interference that can be tolerated without seriously affecting accuracy can vary considerably according to the conditions of the test. As a general rule the maximum permissible a.c. interference current level is 2 mA on the 5 kV range and proportionally less at lower voltages. When the a.c. interference originates from a high impedance source the voltmeter can be used as a milliammeter with an approximate f.s.d. of 10 mA. For example if the meter reads 200 V this represents 2 mA and it should be possible to make a test on the 5 kV range. Excessive a.c. interference will normally result in an unstable reading.

If the a.c. interference current is unstable in amplitude, or if transient interference is present this will cause greater difficulty in obtaining measurements as any low frequencies will not be blocked by the input filter on the measurement circuit. This problem will be most acute when measuring very high values of resistance on low voltage ranges.

PREVENTIVE MAINTENANCE

It is good practice to make regular tests of the insulation resistance of all larger machinery and thus detect any incipient faults. When the tests are entered in the logbook a considerable variation between test results will be noted. It is therefore important to test under similar conditions each time and to note the current weather status.

Damp weather — or damp conditions of use or storage — can cause large reductions in insulation resistance. Drying out by heat or by operation for a period, should give a more consistent and appropriate insulation resistance value.

A counter effect to that above occurs because the insulation resistance of the varnishes used in the construction of machine windings becomes lower when hot than when cold. Thus for constant comparisons the temperature of the machine under test should also be noted.

The best plan is to make regular insulation checks as soon as possible after the machine has been shut down. The insulation resistance is then likely to be at its lowest operational value, this then would become the figure which would show any continuing mechanical depreciation or potential insulation breakdown.

If the machine stands idle in humid conditions a worse picture might well apply but this would normally be assumed to be safe during the running up to temperature, provided that the resistance at working temperature remained unchanged.

TESTING MOTORS AND GENERATORS

(1) Disconnect the equipment from the line by opening the main switch and removing the main fuses.

(2) Join together BOTH terminals on the motor side of the double pole main switch.

(3) With a contactor operated starter where all the lines to the motor are disconnected at off it is necessary to make tests to earth on both the incoming and outgoing terminals of the starter.

(4) Connect the '−' terminal of the BM11 MEGGER tester to earth using the frame of the motor or switch.

(5) Using the '+' terminal measure the resistance of each part of the circuit in the usual way. If the value is unsatisfactory then separate tests in starter, motor and cables must be carried out to locate the defect.

(6) If the motor itself is suspect, disconnect the supply cables and with one lead connected to the frame carry out the following tests.

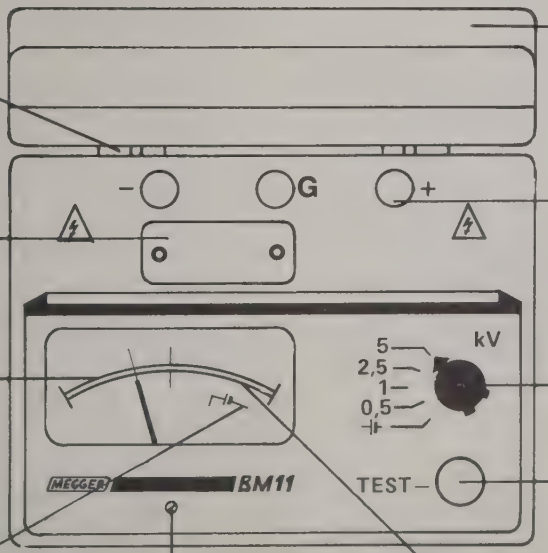
(7) Test with the armature and field windings connected together.

(8) Test with the brushes lifted from contact with the commutator.

(9) Test on the armature only, section by section.

(10) If all resistances are low the fault can usually be remedied by complete and careful cleaning of the machine.
Equipment that has been in service for a period can accumulate metallic, or other conducting, dust especially when mixed with oil from bearings etc. The leakage paths from such deposits are eliminated by thorough cleaning.

Outline Diagram



detachable hinges
charnières séparables
lösbare scharniere
bisagras desmontables

hinged lid
couvercle monté sur charnières
schwenkbarer deckel
tapa abisagrada

terminals
bornes
anschlußklemmen
terminales

battery charger socket cover
cache-prise chargeur de batteries
abdeckung der batterie-ladebuchse
tapa de toma para
cargador de baterias

insulation resistance scale
echelle d'isolement
isolations-widerstandsskala
escala de resistencia de
aislamiento

test voltage selector switch
sélecteur de tension d'essai
prüfspannung-wahlschalter
selector de voltaje de prueba

'TEST' push-button
bouton poussoir de
mise en service
'TEST' drucktaste
botón 'TEST'

battery check
indicateur de charge des batteries
batterieprüfung
indicatador de carga de bateria

meter mechanical adjuster
réglage mécanique du zéro
mechanische nullpunkteinstellung
adjuste del cero mecánico

a.c. and d.c. voltage scale
eschelle de tension,
en courants alternatifs et continus
wechsel- und gleichspannungsskala
escala de voltaje c.a. y c.c.

Mode D'Emploi

AVERTISSEMENT

1. La structure à essayer doit être séparée du réseau — De plus, avant d'entreprendre toute mesure d'isolement, débrancher ou isoler tous les appareils risquant d'être affectés ou détériorés par l'essai.
2. Avant de brancher l'appareil sur le circuit à essayer, vérifier qu'il ne constituera pas une source de danger pour l'opérateur, la tension produite à ses bornes pouvant atteindre 5 kV.
3. Vérifier que les charges capacitives ne se débranchent pas de l'appareil pendant l'essai, risquant alors de rester en état de charge — Lors d'essais sur circuits capacitifs, vérifier que l'appareil indique moins de 50 V avant de le débrancher.
4. Le bouton poussoir 'TEST' peut être verrouillé sur la position 'ON' (Marche) pour effectuer des essais prolongés. Pour ce, il suffit de l'enfoncer et de le faire tourner dans le sens horaire — Dans ce cas de mesure, prendre toutes les précautions nécessaires pour éviter des accidents et que les batteries ne se déchargent totalement — Une décharge excessive des batteries peut être évitée en surveillant leur état de charge tous les quart d'heure.
   De toute façon — sauf quand cela s'avère absolument indispensable — ne pas verrouiller le poussoir de mise en service.
5. Tensions maximales extérieures pouvant être appliquées sur les bornes de l'appareil:
   1000 V entre '+' et '−'
   250 V entre 'G' et '−'

DEPOSE DU COUVERCLE

Si nécessaire, le couvercle peut être déposé pendant l'utilisation de l'appareil — Il suffit d'ouvrir celui-ci complètement et d'appliquer une pression sur son bord d'ouverture, tout en maintenant fermement le boitier de l'appareil; les charnières se séparent alors.

Pour remettre le couvercle en place, le présenter verticalement et enfoncer les charnières dans leurs dispositifs de retenue, tout en maintenant l'appareil, puis fermer le boitier.

VERIFICATIONS PRELIMINAIRES

1. Les bornes de l'appareil étant libres, vérifier que l'aiguille de l'indicateur se trouve sur le repère '∞' de l'échelle supérieure — Si nécessaire, ajuster sa position par le réglage mécanique.
2. Mettre le sélecteur de gamme sur la position '⊣⊢' (contrôle des batteries) et presser le bouton 'TEST' — L'aiguille doit dévier à droite de l'échelle de l'indicateur.
3. Brancher les cordons d'essai sur les bornes '+' et '−' et vérifier que les pinces sont isolées électriquement. Mettre le sélecteur de gamme sur la tension d'essai désirée et appuyer sur le poussoir 'TEST'.
   Vérifier que l'aiguille de l'indicateur s'arrête à proximité du symbôle '∞' de l'échelle. En cas contraire, il se produit une fuite de courant entre les cordons d'essai, les pinces ou les bornes de l'appareil. Relâcher le poussoir et rechercher la cause de cette fuite.
4. Court circuiter les cordons par leurs pinces. Appuyer sur le poussoir 'TEST' et vérifier que l'aiguille vient se placer sur le '0' de l'échelle de l'indicateur — En cas contraire, contrôler la continuité des cordons d'essai.

MESURE D'ISOLEMENT PAR RAPPORT A LA TERRE

1. Exécuter les vérifications préliminaires indiquées ci-dessus.
2. Brancher le cordon relié à la borne '+' sur la structure en essai et le cordon relié à la borne '−' à la terre (châssis de l'équipement, etc. . .).
   Remarque: Si la structure en essai est sous tension, celle-ci est automatiquement indiquée sur l'échelle inférieure de l'indicateur. *Ne pas* appuyer sur le bouton poussoir 'TEST'. Eliminer préalablement cette tension (Tension d'alimentation ou tension parasite créée par couplage capacitif ou inductif avec des circuits sous tension).
3. Après avoir sélectionné la tension d'essai désirée, appuyer sur le bouton poussoir 'TEST'.
4. La valeur d'isolement est directement indiquée sur l'échelle supérieure de l'indicateur.

Remarque: De petites oscillations de l'aiguille indiquent que les batteries sont déchargées à 80%; des oscillations plus importantes signalent que celles-ci doivent impérativement être rechargées.

5. Relâcher le bouton poussoir et attendre que la tension indiquée par l'appareil soit inférieure à 50V pour débrancher les cordons d'essai.

MESURE D'ISOLEMENT ENTRE FILS

1. Exécuter les vérifications préliminaires comme indiqué ci-dessus.
2. Brancher un cordon d'essai sur chaque conducteur et réaliser l'essai comme indiqué aux paragraphes 3, 4 et 5 du chapitre précédent.

UTILISATION DE LA BORNE DE GARDE 'G'

La borne de garde n'est généralement pas utilisée lors des mesures d'isolement courantes. Toutefois, en présence de fuites de surface (particulièrement sur les câbles), cette borne permet alors d'éliminer les effets de ce phénomène.

Enrouler fermement un fil nu autour de l'isolant du conducteur, entre celui-ci et la gaine extérieure, et le relier à la borne de garde 'G' (voir schéma page 12).

Nota: Une résistance de fuite de surface inférieure à 20MΩ provoquera des erreurs dans les mesures.

INDICATION D'ETAT DES BATTERIES

De légères oscillations de l'aiguille de l'indicateur (env. 2mm d'amplitude à 1Hz) indiquent que les batteries sont déchargées à plus de 80% — L'appareil peut encore être utilisé, mais il sera nécessaire de recharger les batteries le plus tôt possible.

Des oscillations importante de l'aiguille (50mm d'amplitude), rendant impossible toute mesure, indiquent que les batteries doivent être immédiatement rechargées, avant toute nouvelle utilisation de l'appareil.

CHARGE DES BATTERIES

Remarque: L'appareil ne doit pas être utilisé en mesures pendant la charge des batteries.

1. Déconnecter l'appareil de tout circuit extérieur et retirer les cordons d'essai.
2. Retirer le cache prise du chargeur en tirant sur ses deux fixations.
3. Le cordon du chargeur ayant été équipé d'une prise de courant appropriée, le relier à l'appareil et au réseau.
4. Mettre sous tension et laisser les batteries en charge pendant 16 Heures. Un voyant rouge situé près de la prise du chargeur reste allumé pendant la charge.
5. Une fois la charge terminée, couper l'alimentation secteur et retirer le cordon.
6. Avant d'effectuer de nouveaux essais d'isolement, remettre le cache prise en place et l'immobiliser en enfonçant ses 'fixations imperdables'.

   Remarque: Le fait de retirer le cache prise de l'appareil provoque une ouverture dans l'appareil permettant à l'humidité qui aurait pu s'y accumuler, de disparaitre.
   Toutefois, il est nécessaire de recharger les batteries dans un environnement sec et de remettre ce cache en place avant d'utiliser l'appareil *in situ*.

Kurze Betriebsanweisungen

VORSICHTSMASSNAHMEN

1. Die zu prüfenden Geräte müssen abgeschaltet sein. Vor Ausführung der Isolationsprüfungen sind alle zur Prüfung kommenden Apparate abzuklemmen und zu trennen.
2. Beim Anschluß des Prüfgeräts an den Stromkreis ist darauf zu achten, daß die an den Klemmen des Prüfgeräts anstehende Spannung, bis zu 5 kV, für den Benutzer keine Gefahrensquelle darstellt.
3. Während der Prüfung ist darauf zu achten, daß kapazitative Belastungen nicht von den Klemmen getrennt werden und dadurch im aufgeladenen Zustand bleiben. Beim Prüfen kapazitativer Stromkreise ist auch sicherzustellen, daß vor Abklemmen des Meßinstruments nach Ausführung einer Prüfung eine Anzeige von < 50 V erscheint.
4. Bei lang ausgedehnten Prüfungen kann die mit 'TEST' bezeichnete Drucktaste durch Drücken und Drehen im Uhrzeigersinn in der eingeschalteten Stellung verklinkt werden. Bei dieser Betriebsart ist besondere Sorgfalt geboten, um eventuelle Beschädigungen bzw. Erschöpfung der Batterie zu vermeiden, insbesondere falls das Prüfgerät unbewacht bleibt.
   Um übermäßige Entladung bis zur möglichen Beschädigung der Batterie zu vermeiden wird empfohlen, das Prüfgerät alle 15 Minuten zu kontrollieren.
   Zur optimalen Sicherheit ist die Taste, falls nicht unbedingt notwendig, niemals zu verklinken.
5. Die Höchstspannungen, die von einer äußeren Quelle an die Klemmen angelegt werden können, betragen:
   1000 V zwischen '+' und '−'
   250 V zwischen 'G' und '−'

ABNEHMEN DES DECKELS

Falls notwendig, kann der Deckel entfernt werden, indem er einfach unter Festhalten des Gerätekorpers durch Druck auf die Öffnungskante nach unten gedrückt wird. Die Scharniere schnappen dann aus.

Zum Wiedereinsetzen des Deckels ist er vertikal zu halten, damit die Scharniere wieder in ihre Klammern ein schnappen, während das Gerat festgehalten wird. Der Decke! kann wieder geschlossen werden.

VORKONTROLLEN

1. Kontrollieren, ob, bei nicht angeschlossenen Klemmen, der Instrumentenzeiger auf der '∞'-Beschriftung der oberen Skala liegt. Falls notwendig, mit der mechanischen Nullpunkteinstellung korrigieren.
2. Die Batteriekontrolle-Stellung '⊣⊢' wählen und die Drucktaste 'TEST' drücken. Dabei sollte sich der Instrumentenzeiger rechts von der Batterie-Kontrollmarkierung auf der Skala befinden.
3. Die Prüfleitungen an die '+' und '−' Klemmen anschließen und sicherstellen, daß die Prüfklemmen nichts berühren. Die entsprechende Prüfspannung wählen und die Drucktaste 'TEST' drücken. Kontrollieren, ob der Instrumentenzeiger sehr nahe der '∞'-Bezeichnung auf der Skala zum Stillstand kommt. Falls nicht, fließt Leckstrom zwischen den Prüfleitungen, Prüfklemmen oder möglicherweise zwischen den Geräteklemmen. Die Drucktaste freigeben und die Leckstromquelle beseitigen.
4. Die '+' und '−' Prüfleitungsklemmen miteinander verbinden. Die Drucktaste 'TEST' drücken und kontrollieren, ob der Instrumentenzeiger auf '0' der oberen Skala steht. Falls nicht, die Prüfleitungen auf Beschädigung prüfen.

ISOLATIONSPRÜFUNG GEGEN ERDE

1. Zuerst die oben erwähnten Vorkontrollen ausführen.
2. Die mit '+' bezeichnete Prüfleitung an das zu prufende Gerät und die mit '⏚' bezeichnete Prüfleitung an Erde anschließen (Geräterahmen usw.).
   Anmerkung: (i) Falls das zur Prüfung kommende Gerät nicht abgeschaltet ist, wird die anstehende Spannung automatisch auf der unteren Instrumentenskala angezeigt.
   Die Drucktaste 'TEST' *nicht* drücken, sondern den Stromkreis zuerst vor weiteren Handhabungen abschalten.
   (ii) Falls das zu prüfende Gerät abgeschaltet ist und trotzdem eine Spannungsanzeige erscheint, deutet das auf die Anwesenheit störender Wechselströme, die durch kapazitative bzw. induktive Kopplung an unter Spannung stehende Stromkreise verursacht werden.

3. Nach Wahl der vorschriftsmäßigen Prüfspannung die Drucktaste 'TEST' drücken.
4. Den Isolations-Widerstandswert unmittelbar von der oberen Skala ablesen.
   Anmerkung: Kleine Schwingungen des Instrumentenzeigers beim Ablesen deuten auf eine erschöpfende Batterie. Bei großen Schwingungen ist die Batterie neu zu laden.
5. Die Drucktaste freigeben und vor Abklemmen der Prüfleitungen warten, bis die Spannungsanzeige des Instruments unter 50 V fällt.

ISOLATIONSPRÜFUNG ZWISCHEN ADERN

1. Die oben erwähnten Vorkontrollen ausführen.
2. Eine Prüfleitung an jede Ader anschließen und dann wie vorher entsprechend der Schritte (3), (4) und (5) der Isolationsprüfung gegen Erde vorgehen.

ANWENDUNG DER SCHUTZKLEMME 'G'

Bei normalen Isolationsprüfungen wird die Schutzklemme nicht verwendet. Um zwischen Körper- und Oberflächenstreuung des Prüflings zu unterscheiden (z.B. bei der Kabelprüfung) kann die Schutzklemme zur Beseitigung der Oberflächenstreuung verwendet werden.

Einen blanken Draht Stramm um die Isolierung zwischen Leiter und Ummantelung wickeln und an die Schutzklemme 'G' anschließen (vgl. Skizze auf Seite 12).

Anmerkung: Bei Oberflächen-Ableitewiderständen von weniger als 20 MΩ treten Meßfehler auf.

NIEDRIGE BATTERIESPANNUNG

Beim Auftreten kleiner Zeigerschwingungen (Amplitude ca. 2 mm bei 1 Hz) während einer Isolationsprüfung ist die Batterie um mehr als 80% erschöpft. Das Meßgerät kann in diesem Zustand noch verwendet werden, jedoch ist die Batterie sobald wie möglich wieder aufzuladen.

Bei großen Zeigerschwingungen (Amplitude ca. 50 mm, so daß Ablesung unmöglich ist) muß vor Wiederverwendung des Meßgeräts die Batterie aufgeladen werden.

LADEN DER BATTERIE

Anmerkung: Beim Laden der Batterie ist das Meßgerät nach Möglichkeit nicht zur Isolationsprüfung zu benutzen.
Bei 'niedriger Batteriespannung' bzw. bei großen Schwingungen des Instrumentenzeigers muß die Batterie wieder aufgeladen werden.

1. Das Prüfgerät von externen Stromkreisen abklemmen und die Prüfleitungen entfernen.
2. Die Abdeckung der Batterie-Ladebuchse durch Ziehen der beiden Abdeckungsklammern entfernen.
3. Einen geeigneten Stecker an die Netzleitung des Ladegeräts anschließen, die Leitung in das Gerät einstecken und dann in eine geeignete Netz-Steckdose.
4. Den Strom einschalten und die Batterie für ca. 16 Stunden laden. Während des Aufladens der Batterie erleuchtet eine rote Signallampe neben der Ladebuchse.
5. Nach dem Aufladen das Netz abschalten und die Ladeleitung entfernen.
6. Vor Wiederaufnahme der Isolationsprüfungen ist die Abdeckung der Batterie-Ladebuchse wieder einzusetzen und durch Druck auf die Abdeckungsklammern zu sichern.
   Anmerkung: Abnehmen der Ladebuchse-Abdeckung gibt eine Entlüftungsöffnung im Gerät frei und gestattet das Entweichen eventueller Feuchtigkeit, die sich im Gerät angesammelt hat. Die Batterie ist daher in trockener Umgebung zu laden, und vor Einsatz des Meßgeräts im Felde ist daher unbedingt die Abdeckung der Ladebuchse wieder aufzusetzen.

Instrucciones Resumidas de Uso

ADVERTENCIAS

1. El equipo a comprobar debe encontrarse sin tensión. Antes de efectuar pruebas de aislamiento, será preciso desconectar y aislar todo aparato que sea objeto de ensayo.
2. Al contectar el instrumento con el circuito, asegurarse de que el usuario no este expuesto a ningún peligro como consecuencia del voltaje producido en los terminales del mismo, que puede alcanzar 5kV.
3. Cuidar de que las cargas capacitivas no se desconectan de los terminales durante el ensayo, permaneciendo con ello el estado de carga. Asimismo, durante la comprobación de los circuitos capacitivos, verificar que el medidor indique 50V antes de desconectarlo después de llevar a cabo un ensayo.
4. Para ensayos de larga duración, el botón 'TEST' puede bloquearse en la posición 'on' (conexión), apretándolo y girándolo hacia la derecha. Cuando se adopte esta modalidad funcional, cuidar de que no se produzcan daños o perjuicios y que no se descargue la batería, especialmente si el medidor permanece inatendido.
   A fin de evitar una descarga excesiva, hasta el punto de ocasionar posibles daños a la batería, conviene verificar el instrumento cada 15 minutos. Para máxima seguridad, nunca se debe bloquear el botón pulsador a menos que sea absolutamente necesario.
5. Los voltajes máximos que pueden aplicarse a los terminales desde una fuente externa, son:
   entre '+' y '−' 1000v
   entre 'G' y '−' 250v

DESMONTAJE DE LA TAPA

Se puede retirar la tapa del medidor durante su uso cuando sea necesario, para lo cual basta abrirla hasta el máximo y ejercer leve presión sobre el borde de apertura mientras que se sujeta firmemente la caja del instrumento; con ello se soltarán los pasadores de bisagra. Para reinstalar la tapa, colocarla en posición vertical o introducir los pasadores en sus soportes mientras que se sujeta el instrumento, cerrando la tapa después.

COMPROBACIONES PRELIMINARES

1. Verificar que, cuando no hay nada conectado con los terminales, la aguja del medidor permanece sobre la marca '∞' de la escala superior, efectuando todo reglaje necesario con ayuda del ajustador mecánico.
2. Seleccionar la posición de comprobación de batería '⊣⊢' y apretar el botón 'TEST'. La lectura del medidor debe situarse a la derecha de la marca de comprobación de batería sobre la escala.
3. Conectar los conductores de prueba con los terminales '+' y '−' cerciorándose de que los clips no hagan ningún contacto. Escager el correspondiente voltaje de prueba y apretar el botón 'TEST'. Verificar que la aguja del medidor se mantenga muy cerca de la marca '∞' de la escala. Si no lo hace, será señal de que hay una fuga entre los conductores de prueba, los clips o, posiblemente, los terminales del instrumento, debiéndose soltar el botón pulsador y determinar el origen de dicha fuga.
4. Unir los clips de los conductores de prueba '+' y ' '. Apretar el botón 'TEST' y verificar que el medidor indique '0' en la escala superior. Si no lo hace, examinar los conductores de prueba por si tuvieran algún defecto.

PRUEBA DE AISLAMIENTO A TIERRA

1. Realizar las comprobaciones preliminares indicadas arriba.
2. Conectar el conductor de prueba '+' con el equipo a ensayar y el conductor de prueba '−' con tierra (bastidor de dicho aparato, etc.).
   Nota: (i) si el aparato a ensayar no esta desexcitado, el voltaje presente en el mismo será indicado automáticamente en la escala inferior del medidor.
   (ii) si se sabe que el equipo a ensayar está desexcitado y sin embargo se obtiene una indicación de voltaje, ello indica la presencia de corrientes parásitas de c.a. debidas al acoplamiento capacitivo o inductivo con ciruitos activos.
3. Una vez seleccionado el correcto voltaje de prueba, apretar el botón 'TEST'.

4. El valor de resistencia del aislamiento podrá leerse directamente en la escala superior.
   Nota: Si, al efectuar la lectura, la aguja presenta leves oscilaciones, ello indica principio de batería baja. Si se producen oscilaciones mayores, será preciso regargar la batería.
5. Soltar el botón pulsador y esperar que le medidor indique una lectura menos de 50 V antes de desconectar los conductores de prueba.

PRUEBA DE AISLAMIENTO ENTRE CABLES

1. Realizar las comprobaciones preliminares indicadas arriba.
2. Conectar un conductor de prueba con cada cable y, a continuación, efectuar las operaciones (3), (4) y (5) correspondientes a la prueba de aislamiento a tierra.

EMPLEO DEL TERMINAL DE GUARDA 'G'

Para las pruebas básicas de aislamiento no se empleará el terminal de guarda. A fin de distinguir entre fugas de aislamiento propiamente dichas y fugas superficiales del aislante en la muestra objeto de ensayo (v.g. durante la comprobación de cables) se puede utilizar el terminal de guarda para suprimir el efecto de las fugas de superficie.
Para ello, enrollar un hilo desnudo alrededor del aislamiento, entre el conductor y la vaina externa, conectándolo con el terminal de guarda 'G' (véase el croquis en la página 12).
Nota: si la resistencia de fugas de superficie es menor de 20 MΩ se producirán errores de medida.

INDICACIÓN DE BAJO VOLTAJE BATERIA

Si la aguja presenta leves oscilaciones (amplitud aprox. 2 mm a 1 Hz) durante una prueba de aislamiento, ello indica que la batería está descargada en más de un 80%. Se puede seguir empleando el instrumento en estas condiciones, pero la batería debe ser recargada lo más pronto que sea posible.

Si el indice acusa oscilaciones importantes (amplitud aprox. 50 mm, imposibilitando con ello la lectura) no se debe utilizar el instrumento hasta que haya sido recargada la batería.

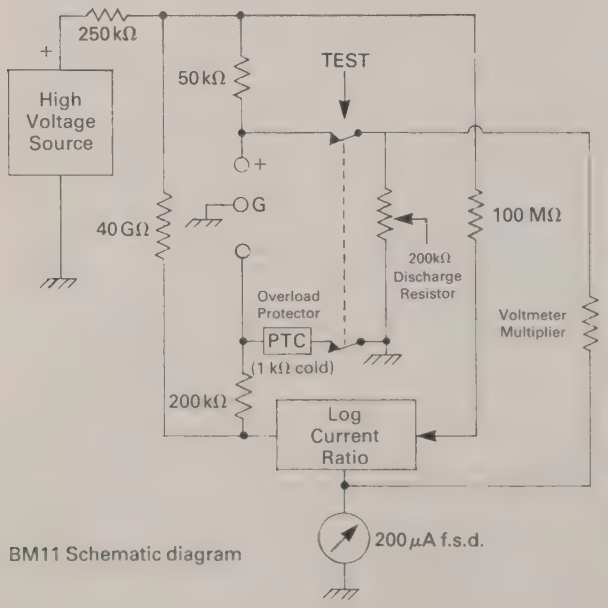
CARGA DE LA BATERÍA

Nota: no se deben efectuar pruebas de aislamiento con el instrumento durante la operación de carga de la batería. Será necesario recargar la batería si el 'indicador de carga' acusa un valor bajo o si la aguja ejerce oscilaciones importantes.

1. Desconectar el medidor de todo circuito externo y retirar los conductores de prueba.
2. Destapar la toma correspondiente al cargador de batería, tirando de los dos clips que sujetan la tapa.
3. Después de colocar una clavija apropiada en el cable del cargador de batería, enchufar dicho cable al instrumento y conectarlo con la toma de la red.
4. Conectar la tensión de red y dejar transcurrir unas 16 horas para que se cargue la batería. El aviso luminoso rojo adyacente a la toma de carga permanecerá encendido durante la carga de la batería.
5. Efectuada la carga, interrumpir la alimentación de la red y retirar el cable de carga de la batería.
6. Antes de reiniciar las pruebas de aislamiento, instalar la tapa de la toma correspondiente al cargador y sujetarla con sus clips.
   Nota: Al destapar la toma del cargador se descubre un dispositivo de ventilación incorporado en el instrumento, lo que permite la evacuación de toda humedad que haya podido acumularse en el interior. Por lo tanto, es necesario cargar la batería en un ambiente seco, siendo muy importante reinstalar la tapa del cargador antes de destinar el instrumento a trabajos de campo.

Circuit Description

(see also the circuit diagram)
There are two main sections within the tester, the inverter, producing the high test voltage, and the current measuring circuit. The high voltage '+' terminal is positive with respect to the guard 'G' and '−' (measurement) terminals.



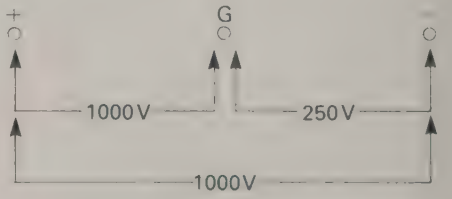
BM11 Schematic diagram

The inverter operates in three modes:

(i) Constant output voltage for low loads, i.e. resistances $>10\,M\Omega$.
(ii) Constant output power for heavy loads, i.e. resistances approx. $5\,M\Omega$.
(iii) Constant output current for very heavy loads and short circuit.

The measurement circuit uses a pair of matched transistors to produce a voltage proportional to the logarithm of the ratio of leakage current (current through test sample) to applied voltage. The scale shape is of the basic form $\frac{1}{5}\log_{10}\frac{100}{R}$ where R is the resistance of the test samples in MΩ. Deliberate cramping at each end of the scale enables the 0 and ∞ marks to be shown and still give five decades of resistance measurement.

The maximum allowable continuous voltage that may be applied to the test terminals is:–



The maximum current through all terminals is 2 mA.

Battery life
Current is only drawn from the battery while the 'TEST' push-button is pressed. The battery life is typically 8 hours if the instrument is used at 5 kV test voltage, with varying resistive loads with parallel capacitance between 0 and 2 μF.

However, the instrument can supply 4,75 kV to a 10 MΩ load and if used in such a condition continuously will exhaust the battery in 2½ hours.

Note:— under short circuit conditions the 1 mA current limit comes into operation and the battery drain is then quite low.

A battery check facility is provided on the rotary switch. This checks the battery voltage with a dummy load when the 'TEST' push-button is pressed. However, checking nickel cadmium cells in this way is of very limited value as their voltage gives no indication of their state of charge other than showing if they are completely exhausted.

To give the user an indication when the battery is approaching an exhausted state a low battery detection system is used which involves causing part of the battery to drain at a slightly higher rate than the remainder. This part of the battery reaches the low voltage state first. This condition is detected, and an oscillator is activated which causes small, but visible oscillations on the meter pointer. When the remainder of the battery becomes so exhausted that there is insufficient voltage to operate the instrument properly, a voltage detector circuit causes large oscillations to be superimposed on the meter pointer thus preventing a measurement being made.

The only adjustment available to the operator is the mechanical pointer adjuster which is located on the front panel. This may need to be re-set to infinity if the instrument has been subjected to mechanical shock or vibration. The electronic circuits are sufficiently stable so that no adjustment should ever be required during normal use.

If a fault develops, the instrument should only be repaired by qualified personnel who are aware that dangerous voltages are developed in parts of the instrument circuit, and who will exercise extreme caution while working on the instrument when it has been removed from its case.

Accessories

Instrument Repairs and Spare Parts

WARRANTY

All products supplied by BIDDLE Instruments are warranted against all defects in material and workmanship for a period of one year following shipment. Our liability is specifically limited to replacing or repairing, at our option, defective equipment. Equipment returned to the factory for repair will be shipped Prepaid and Insured. The warranty does not include batteries, lamps or tubes, where the original manufacturer's warranty shall apply. WE MAKE NO OTHER WARRANTY.

The warranty is void in the event of abuse.

REPAIRS

BIDDLE Instruments maintains a complete instrument repair service. Should this instrument ever require repairs, we recommend it be returned to the factory for repair by our instrument specialists. When returning instruments for repairs, either in or out of warranty, they should be shipped Prepaid and Insured, and marked for the attention of the Instrument Service Manager

Components List

INSTRUMENTATION PRINTED CIRCUIT BOARD

R8	Resistor	5,6 kΩ ± 5%	1/3 W
R9	Resistor	47 kΩ ± 5%	1/3 W
R13	Resistor	560 Ω ± 5%	1/3 W
R14	Resistor	180 kΩ ± 5%	1/3 W
R15	Resistor	220 Ω ± 10%	7 W
R17	Resistor	3,3 Ω ± 5%	1/3 W
R18	Resistor	100 Ω ± 5%	1/3 W
R20	Resistor	8,2 kΩ ± 5%	1/3 W
R21	Resistor	8,2 kΩ ± 5%	1/3 W
R22	Resistor	100 Ω ± 5%	1/3 W
R23	Resistor	1 kΩ ± 5%	1/3 W
R24	Resistor	1 kΩ ± 5%	1/3 W
R28	Resistor	47 Ω ± 5%	1/3 W
R29	Resistor	4,7 kΩ ± 5%	1/3 W
R30	Resistor	1 kΩ ± 5%	1/3 W
R31	Resistor	2,7 kΩ ± 5%	1/3 W
R35	Resistor	22 Ω ± 5%	1/3 W
R37	Resistor	22 Ω ± 5%	1/3 W
R38	Resistor	22 Ω ± 5%	1/3 W
R39	Resistor	1,2 kΩ ± 5%	1/3 W
R46	Resistor	100 kΩ ± 5%	1/3 W
R47	Resistor	15 kΩ ± 5%	1/3 W
R48	Resistor	100 kΩ ± 5%	1/3 W
R51	Resistor	220 kΩ ± 5%	1/3 W
R53	Resistor	310 kΩ ± 1%	1/4 W
R54	Resistor	160 kΩ ± 1%	1/4 W
R55	Resistor	27 kΩ ± 1%	1/4 W
R56	Resistor	27 kΩ ± 1%	1/4 W
R57	Resistor	36 kΩ ± 1%	1/4 W
R58	Resistor	62 kΩ ± 1%	1/4 W
R59	Resistor	47 Ω ± 5%	1/3 W
R61	Potentiometer	1 MΩ ± 20%	
R62	Resistor	50 MΩ ± 5%	1/2 W
R63	Resistor	56 kΩ ± 5%	1/3 W
R64	Potentiometer	10 kΩ ± 20%	
R65	Resistor	56 kΩ ± 5%	1/3 W
R67	Resistor	33 kΩ ± 2%	1/3 W
R71	Resistor	3,9 MΩ ± 5%	1/3 W
R72	Resistor	33 kΩ ± 2%	1/3 W
R73	Potentiometer	10 kΩ ± 20%	
R74	Resistor	3,3 kΩ ± 5%	1/3 W
R75	Resistor	10 kΩ ± 5%	1/3 W
R76	Resistor	33 kΩ ± 2%	1/3 W
R77	Resistor	1 MΩ ± 5%	1/3 W
R78	Resistor	47 kΩ ± 5%	1 W
R79	Resistor	3,9 kΩ ± 5%	1/3 W
R80	Potentiometer	100 kΩ ± 20%	
R81	Resistor	1 MΩ ± 5%	1/3 W
R82	Thermister	1 kΩ cold	
R83	Resistor	100 kΩ ± 5%	1/3 W
R84	Resistor	100 kΩ ± 5%	1/3 W
R85	Resistor	1 MΩ ± 5%	1/3 W
R86	Resistor	100 kΩ ± 5%	1/3 W
R87	Resistor	12 kΩ ± 5%	1/3 W
R88	Platinum Resistor (100 Ω at 0°C)		
R90	Select on test		
R91	Select on test		
R92	Resistor	2,2 kΩ ± 1%	1/4 W
R93	Resistor	1 MΩ ± 5%	1/3 W
R95	Resistor	27 kΩ ± 5%	1/3 W
R96	Potentiometer	500 Ω ± 20%	
R97	Resistor	220 kΩ ± 5%	1/3 W
R98	Resistor	10 MΩ ± 5%	1/3 W
R99	Resistor	10 MΩ ± 5%	1/3 W
R101	Resistor	3,3 MΩ ± 5%	1/3 W
R103	Resistor	3,3 kΩ ± 5%	1/3 W
R104	Resistor	220 kΩ ± 5%	1/3 W

R106	Resistor	27 kΩ ± 5%	1/3 W
R108	Resistor	100 kΩ ± 5%	1/3 W
R112	Resistor	14 kΩ ± 1%	1/4 W
R113	Potentiometer	100 kΩ ± 20%	
R114	Resistor	390 kΩ ± 5%	1/3 W
R115	Resistor	6,8 kΩ ± 5%	1/3 W
R116	Resistor	100 kΩ ± 5%	1/3 W
R117	Resistor	390 Ω ± 2%	1/3 W
R118	Resistor	27 kΩ ± 5%	1/3 W
R119	Potentiometer	100 kΩ ± 20%	
R120	Resistor	220 kΩ ± 5%	1/3 W
R129	Resistor	2,2 kΩ ± 5%	1/3 W
R130	Resistor	3,9 kΩ ± 1%	1/4 W
R131	Potentiometer	1 kΩ ± 20%	
R132	Resistor	3,9 kΩ ± 1%	1/4 W
R133	Resistor	14 kΩ ± 1%	1/4 W
R135	Resistor	10 kΩ ± 5%	1/3 W
R136	Resistor	10 MΩ ± 5%	1/3 W
R137	Resistor	220 kΩ ± 5%	1/3 W
R138	Resistor	1 MΩ ± 5%	1/3 W
R139	Resistor	13 kΩ ± 2%	1/3 W
R140	Resistor	6,8 Ω ± 10%	7 W
R141	Resistor	47 kΩ ± 5%	1/3 W
R142	Resistor	47 kΩ ± 5%	1/3 W

C2	Capacitor	100 μF	16 V electrolytic
C7	Capacitor	10 μF	16 V electrolytic
C8	Capacitor	470 μF	40 V electrolytic
C9	Capacitor	0,1 μF ± 10%	63 V
C11	Capacitor	0,01 μF ± 10%	63 v
C12	Capacitor	0,01 μF ± 10%	63 V
C17	Capacitor	100 μF	16 V electrolytic
C18	Capacitor	100 μF	16 V electrolytic
C19	Capacitor	0,1 μF ± 10%	63 V
C20	Capacitor	0,1 μF ± 10%	63 V
C21	Capacitor	0,1 μF ± 10%	63 V
C25	Capacitor	1 μF ± 20%	400 V
C26	Capacitor	1 μF ± 20%	400 V
C27	Capacitor	47 pF ± 2%	63 V
C28	Capacitor	1 μF ± 20%	400 V
C29	Capacitor	1 μF ± 20%	400 V
C30	Capacitor	0,1 μF ± 10%	100 V
C38	Capacitor	0,47 μF ± 10%	10 V
C39a	Capacitor	0,01 μF ± 10%	63 V
C39b	Capacitor	0,01 μF ± 10%	63 V
C40	Capacitor	0,1 μF ± 10%	100 V
C41	Capacitor	0,1 μF ± 10%	100 V
C42	Capacitor	0,01 μF ± 10%	63 V
C43	Capacitor	0,01 μF ± 10%	630 V d.c. 300 V a.c.
C45	Capacitor	0,1 μF ± 10%	63 V

D1 to D4	Diode	1N4002
D7	Zener diode	BZY88C9V1
D9	Diode	1N4148
D10	Diode	1N4002
D12	Diode	1N4148
D13	Diode	1N4148
D16	Diode	1N4002
D17	Diode	1N4002
D21	Diode	BC183
D22	Diode	BC183
D22a	Diode	BC183
D30 to D35	Diode	1N4148
D36	Zener diode	6,4 V 1N4565
D37	Diode	1N4002

Components List

TR5	Transistor	BC213
TR6	Transistor	BC183
TR7	Transistor	FT2955
TR8	Transistor	BC183
TR9	Transistor	BC213
TR11	Transistor	2N3053
TR14	Transistor	BC213
TR16	Transistor	BC213
TR19	Transistor	BC183
TR21	Transistor	FT2955
TR22	Transistor	BC183
TR26	Transistor	BC213
TR27	Transistor	BC183 } Matched to 2 mV
TR28	Transistor	BC183 }
TR29	Transistor	BC213
TR30-TR34	Transistor	BC183
TR35	FET	J113

IC3	Integrated circuit	CA3140
IC4	Integrated circuit	IC4001
IC5	Integrated circuit	CA3140

SVP1	Surge voltage protector	part no. 28863-285
T2	Low voltage transformer	part no. 6231-067
SW1B	Micro switch	part no. 25475-581
S2	Rotary switch	part no. 25462-887

HIGH VOLTAGE PRINTED CIRCUIT BOARD

R1	Resistor	270 kΩ ± 5%	1/3 W
R2	Potentiometer	100 kΩ ± 20%	
R3	Resistor	270 kΩ ± 5%	1/3 W
R3a	Resistor	470 kΩ ± 5%	1/3 W
R4	Resistor	4,7 kΩ ± 5%	1/3 W
R5	Resistor	150 kΩ ± 5%	1/3 W
R6	Resistor	27 kΩ ± 5%	1/3 W
R7	Resistor	100 kΩ ± 5%	1/3 W
R10	Resistor	1,5 kΩ ± 5%	1/3 W
R11	Resistor	3,9 kΩ ± 5%	1/3 W
R12	Resistor	1,8 kΩ ± 5%	1/3 W
R16	Resistor	680 Ω ± 5%	1/3 W
R16a	Resistor	470 kΩ ± 5%	1/3 W
R19	Resistor	330 Ω ± 5%	1/3 W
R25	Resistor	680 Ω ± 5%	1/3 W
R26	Resistor	22 Ω ± 5%	1/3 W
R27	Resistor	2,2 kΩ ± 5%	1/3 W
R32	Resistor	1 kΩ ± 5%	1/3 W
R33	Resistor	47 kΩ ± 5%	1/3 W
R34	Resistor	47 kΩ ± 5%	1/3 W
R36	Resistor	4,7 kΩ ± 5%	1/3 W
R40	Resistor	680 Ω ± 5%	1/3 W
R41	Resistor	4,7 kΩ ± 5%	1/3 W
R42	Resistor	2,2 kΩ ± 5%	1/3 W
R43	Resistor	27 kΩ ± 5%	1/3 W
R44	Resistor	27 kΩ ± 5%	1/3 W
R45	Resistor	27 kΩ ± 5%	1/3 W
R49	Resistor	1,5 kΩ ± 5%	1/3 W
R50	Resistor	10 Ω ± 5%	1/3 W
R50a	Resistor	3,3 kΩ ± 5%	1/3 W
R53	Resistor	100 Ω ± 5%	1/3 W
R60	Resistor	10 Ω ± 5%	1/3 W
R66	Resistor	39 Ω ± 5%	1/3 W
R68	Resistor	1 kΩ ± 5%	1/3 W
R69	Resistor	1 kΩ ± 5%	1/3 W
R70	Resistor	27 kΩ ± 5%	1/3 W
R89	Resistor	100 MΩ ± 2% (5kV max., voltage coeff. 3ppm/V)	
R94	Resistor	100 MΩ ± 2% (5kV max., voltage coeff. 3ppm/V)	
R100	Resistor	200 MΩ ± 5% (5kV)	
R102	Resistor	82 kΩ ± 5%	1 W

R105	Resistor	82 kΩ ± 5%	1 W
R107	Resistor	82 kΩ ± 5%	1 W
R111	Resistor	47 kΩ ± 5%	1 W
R121	Resistor	39 kΩ ± 5%	2 W
R122	Resistor	39 kΩ ± 5%	2 W
R123	Resistor	1,8 MΩ ± 5%	(5 kV)
R124	Resistor	39 kΩ ± 5%	2 W
R125	Resistor	39 kΩ ± 5%	2 W
R126	Resistor	39 kΩ ± 5%	2 W
R127	Resistor	4,7 kΩ ± 5%	⅓ W
R128	Potentiometer	1 MΩ ± 20%	
R143	Resistor	100 kΩ ± 5%	⅓ W
C1	Capacitor	0,01 μF ± 10%	63 V
C3	Capacitor	0,1 μF ± 10%	100 V
C4	Capacitor	470 pF ± 5%	100 V
C5	Capacitor	470 pF ± 5%	100 V
C6	Capacitor	470 pF ± 5%	100 V
C10	Capacitor	0,1 μF ± 10%	63 V
C13	Capacitor	47 pF ± 2%	63 V
C14	Capacitor	0,1 μF ± 10%	63 V
C15	Capacitor	0,1 μF ± 10%	63 V
C16	Capacitor	470 pF ± 5%	100 V
C22	Capacitor	100 μF	16 V electrolytic
C23	Capacitor	100 μF	16 V electrolytic
C24	Capacitor	100 μF	16 V electrolytic
C31	Capacitor	0,047 μF	(1,5 kV)
C32	Capacitor	0,047 μF	(1,5 kV)
C33	Capacitor	0,047 μF	(1,5 kV)
C34	Capacitor	0,047 μF	(1,5 kV)
C35	Capacitor	0,047 μF	(1,5 kV)
C36	Capacitor	0,047 μF	(1,5 kV)
C37	Capacitor	0,047 μF	(1,5 kV)
C46	Capacitor	2,2 μF	35 V electrolytic

D5	Diode	1N4148
D6	Diode	1N4148
D8	Zener diode	BZY88 C5V1
D14	Zener diode	1N4162B
D15	Diode	1N4002
D18	Zener diode	BZX79C68
D19	Diode	1N4148
D20	Diode	1N4148
D23	Diode	1JK30
D29	Diode	1JK30
D38 to D40	Diode	1N4148
D41	Zener diode	BZY88C9V1
TR1	Transistor	BC183
TR2	Transistor	BC183
TR3	Transistor	BC213
TR4	Transistor	BC183
TR10	Transistor	BC213
TR12	Transistor	BC213
TR13	Transistor	BC183
TR15	Transistor	BC213
TR17	Transistor	BC183
TR18	Transistor	BC183
TR20	Transistor	2N3053
TR23	Transistor	BDX36
TR24	Transistor	BC213
TR25	Transistor	BC183
IC1	Integrated circuit	CA3140
IC2	Integrated circuit	IC4001
T1	Transformer	240 V : 12 V 12 VA

Button P

15568-4 (2) stock of 3 60.00

EY 25111-845 (1) single coil 30.00

Sold.

Biddle INSTRUMENTS

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Parts of this instrument are the subject of patent applications

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